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IStage: An Interactive Stage System

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Abstract

At present, performers need a technical team of experts to control lights, on-stage displays, and to actuate multiple devices simultaneously. All these activities have to be arranged in a complex choreography in order to allow the audience to experience the illusion of the interaction between these devices and the performer's movements. IStage is an interactive system that allows controlling the on-stage equipment through the use of body movements and gestures. The aim is to enhance the performance on-stage and at the same time to enrich the audience's overall engagement with the show. The project contributes by presenting a generic toolkit for artists; to enable interactive performances, as well as that it is cost-effective, easy-to-use, and easy-to-install. The initial prototype involves a Microsoft Kinect 2 used as the primary sensing device to track the body gestures, in combination with a sound impact sensor. IStage uses a set of output devices: a projector, led strips, a bubble machine and audio. Lastly, we also present the results of a formative study.

Author Keywords

Interactive systems, gestures, performing arts, interactive stage, artistic interaction toolkit

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces.

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Figure 1: *Happy mode (top), sad mode (bottom)*

Introduction

Currently, putting up a performance is a long and expensive process. On one side, expert performers have a technical team of experts to control different things on stage such as lights, on-stage displays, actuating devices, etc. In fact, in most cases the success of the performance itself relies on the skills of this team. On the other hand amateur performers must set up their performance on their own, with no support from a team of experts. In both cases the performance is designed before the show and as a result the on-stage effects (e.g. projection) are synchronized with the performer's movement who must learn a precise choreography. This limits the performer's ability to improvise during the show because every part is planned beforehand. It is also important to consider the difficulty of freely manipulating on-demand any of the on-stage parts during the performance, for example: as a response to the audience feedback. In order to reduce the need for the technical team's involvement and to enhance performers' control, we propose IStage.

The project investigates the design of a low-cost, easy-to-use and easy-to-install interactive stage system for performers. While a substantial body of research already exists in gesture recognition and interactive stage systems, they are hardly affordable and manageable by independent performers. This provides a strong motivation for exploring such an interactive system.

IStage allows the performer to control the whole stage setup in real-time with a set of gestures. IStage is an interactive system that uses a Microsoft's Kinect 2 as the main input. The Kinect tracks the performer's gestures and a sound sensor detects the frequency of the music with a set of output devices; a projector, light sources, a bubble machine and audio.

A single performer can interact and actuate the on-stage devices connected to our system. In small performances, the performer has the flexibility to improvise thus better preserving the interaction and engagement with the audience.

Firstly, we present our system as well as a formative study with 16 participants. We then discuss about how the system can be extended in the future. The proposed system is a step towards an interactive stage toolkit for artists to create their own interactive performance experiences to ultimately enhance the overall engagement with the audience. Our initial work can be relevant in a variety of entertainment environments and business contexts such as concerts, theatre plays, speeches, presentations, etc.

Related work

There have been several attempts to build systems for controlling graphics and sounds using user gestures or emotions [7, 8, 10]. The closest to our system is *Cyclic*, a dancer-controlled augmentation of the performance through graphics and music, using the dancer movements as input data to these components [1]. The device detects the movements and then processes it through a motion-tracking module and generates specific parameters as output [1, 5]. Then these parameters are used to control instances in order to create graphics and sound. As a result, the dance performance is enhanced with additional graphics projected onto the screen, as well as an interactive soundscape [1, 4]. However this system still requires the production of a planned choreography. *EyesWeb* is a modular system for the real-time analysis of face expressions and gestures; such information can be used to control and generate visual media [2]. Music via

Motion is designed to translate physical movements of the performers to trigger multimedia events [6].

Previous work also focuses on tracking the performer's gestures by augmenting him/her with additional sensor technology such as motion capture suits [11,12], handheld input device [13], or visual markers attached to the body [14,15]. However, as described in [1], such techniques have limitations, in particular the technology employed can restrict the range of movements of the performers and can also limit the choice of costumes.

IStage overcomes these restrictions, as it does not require additional equipment to be worn. It also goes further than existing work by allowing the performer not only to control some aspects of the graphics and sounds but also to control the entire stage, which can be composed of multiple devices such as lights and other electronic devices (e.g. fog machine, bubble machine, odor machine etc.).

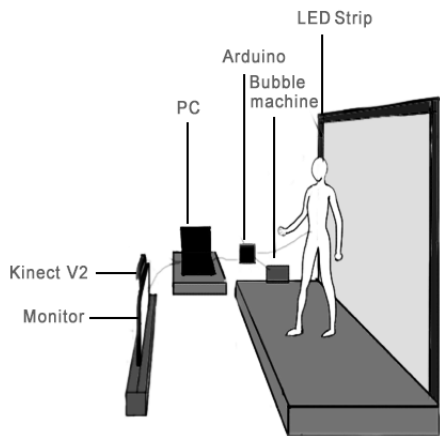


Figure 2: IStage setup

Design

In order to guide the design of our system, we conducted an interview with a dancing performer. The purpose of this was to identify the type of activities a performer does when dancing and to highlight the requirements for our system. As a result our system is designed to follow two original principles based on the dancing performer's comments: (1) the performer can not only control the graphics and sounds but also many other elements present on-stage such as lights or electronic equipment; (2) the performer can interact with the system with different levels of control. In particular the performer can control the media elements directly, e.g. pointing at a light to direct it somewhere. But also the performer can choose to let the system take automatic control when

needed, e.g. when he/she needs concentration during a specific dance move.

Different level of control

The main input source in our system is the body movement and hand gestures. The system captures these gestures and then uses them to control or to trigger different input modes: manual, semi-automatic, and fully automatic.

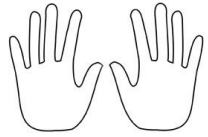
- Manual mode: this mode allows controlling a single piece of equipment at a time, for example the user can turn on/off a bubble machine.
- Semi-automatic mode: this mode allows the performer to control more abstract elements or media, e.g. the color of the LED strip as well as the color of the projected graphics.
- Fully-automatic mode: this mode allows the performer to select from a preset of moods. This mode is automatic because it can be used to provide the performer with the space to focus only on the performance, without the need to control any of the output devices.

There are also two types of moods: the happy mood, which sets up the stage with vivid color and lights, and the sad mood, which sets up the stage with dark color and projection graphics (Figure 1).

Gestures

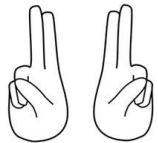
The type of hand gestures that we use are open state, closed state, and lasso state:

- To trigger the manual mode, the performer points directly to the device to be actuated using a combination of a closed hand state and a lasso state as shown in Figure 3. In our prototype we



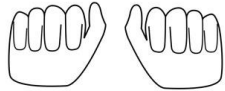
Automatic mode

Both hands in open palm state



Happy mode

Both hands in lasso state



Sad mode

Both hands in close fist state



Point to actuate a device

A lasso and a closed hand

Figure 3: Control gestures

implemented this type of control to actuate the bubble machine.

- To trigger the fully automatic mode, the performer must use both hands in an open hand state (Figure 3a). Once it is triggered, projected particles are displayed behind the performer, and they follow the hand movements. The LED strip color changes to the same color as the particles depending on the position of the hands on the vertical axis, relative to the area that the Kinect covers.
- To trigger the happy mood, the performer needs to have the fully automatic mode activated, while then to use both hands in the lasso state (Figure 3b). In this mode, the application projects lines of equal heights varying in colors, reacting to the sound of the music captured from the computer's microphone. Similarly the LED strips will rapidly showcase the same range of the color spectrum.
- To trigger the sad mood, again, the performer needs to have the fully automatic mode activated, while then to use both hands in a close fist state (Figure 3c). The application creates a grid of blue particles that are sound reactive, moving slowly towards the center of the spine of the performer. The color of the LED strip is shifting through a very short range in the color spectrum from white to blue.

Implementation

The hardware setup consists of a Microsoft Kinect V2 that tracks body movements and gestures. In addition, we use a sound impact sensor to detect the intensity of the music via an Arduino, using serial port communication. These two devices are the input sources. The output sources are the lights (LED strips), the graphics projection as well as a bubble machine. Apart from the Kinect and the projector, all the other devices are

connected to an Arduino board. Finally, in order to increase the accuracy of the system, the performer gets instant feedback through an on-stage monitor to check whether each interaction is activated or not. On the other side, the software is a combination of: Kinect SDK, Cinder framework and Arduino IDE. The Cinder framework is a library based on C++ used on the graphics and audio development in our system.

Usability study

We performed a preliminary study in order to gather feedback from end-users.

Participants

We had 16 participants from our institution, with ages varying from 18 to 45 years old.

Task

The participants were given a set of instructions on how to use IStage by utilizing the previously mentioned gestures. Additionally we provided a 2 minutes basic training to each user along with a task sheet to test their performance while using the system for the first time. We asked them to manipulate the stage environment by using the available gestures to complete a specific task: (1) trigger the bubble machine (2) create a happy mood (3) take control of the light.

Data collected

After the completion of the tasks, the users provided feedback regarding their experience. Firstly they were asked if they have used a Kinect or if they had any stage performance experience before. Using a 5 pt Likert scale they were then asked to rate our system in terms of easiness of use. We then conducted an interview to gather additional feedback. In particular, we asked them

if they had any issue with the system, how they found the gestures and their overall experience satisfaction.

Results

Among the 16 participants, 7 of them had already used a Kinect before. 5 of them had stage performance experience. For the question "is IStage easy to manipulate" 7 participants answered 5 (very easy), 6 participants answered 4 (easy) and the rest of them, i.e. 3 participants answered 3 (medium). The answers are thus quite positive.

Among the 16 participants, 15 managed to finish the given task successfully within 3 minutes, suggesting that they had no problem to use the application. Only one failed to create a happy mood because the Kinect couldn't recognize his lasso hand gesture, which was mainly happening due to the fact that he had long sleeves covering his hands. Besides that, all of the participants responded that they had no difficulty to remember the gestures.

Participants found that the application of the bubble machine (7 participants) and the ability to control the lights (5 participants) can be effectively applied to improve stage performances. Additionally, 6 participants think that the system was designed effectively for stage performing and could increase the interactivity between performers and devices.

Furthermore, 7 participants did not like the fact that the device takes time to recognize gestures, as there is a tracking latency, which affected their experience satisfaction. This latency is because we have set a timer between the gesture and the effect in order to avoid the users accidentally triggering events. In addition, 3

participants said that the variety of gestures was not adequate and that there is room for improvement. 4 participants mentioned that the lasso hand gesture didn't feel natural or generic enough to pose when doing a performance. Lastly, 1 participant noticed that the movement of the performer is limited to a certain area of the stage, since the Kinect can only capture a specific area.

Conclusion and future work

This paper introduces IStage, a toolkit that enables real time control of events during a performance. Our system allows the performer to control a combination of sound and graphics, but also other elements on-stage such as electronic equipment. After a first usability evaluation, we gathered interesting feedback to further improve our system. In our future work we would like to experiment with many other output devices like fog machines, sprinklers and addressable LED strip arrays to enhance both the performance and public experience.

Furthermore, we recognize the importance of designing and implementing a user interface for the end-user to allow customization of different gestures and actions. This would give them total control while performing, and the project could then make a step towards the development of a final product, a toolkit to create entirely customizable interactive performances. It is also important to investigate on different ways of interaction with the system to blend with the performance in a more natural way. At the time, the application can only recognise hand gestures, but in the future the interactions could be based on full body movement, making the interaction a seamless bond with the performance itself. Lastly, another extension of our setup would be to capture multiple performers at a time;

so multiple actions can manipulate the output devices simultaneously.

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